IBM watsonx.ai Hackathon Deliverables

Team CodeX - Extreme Weather RAG System

Deliverable 1: Problem and Solution Statement

Climate change has intensified extreme weather events worldwide, making them more frequent, severe, and unpredictable. Communities face hurricanes, tornadoes, heat waves, flash floods, and severe storms with limited advance warning systems that often lack the contextual intelligence needed for proactive community protection. Lives are lost because people cannot access comprehensive, AI-powered analysis that combines real-time conditions with historical patterns to predict extreme weather threats before they become deadly. Traditional weather forecasting provides basic data but fails to deliver the intelligent risk narratives and actionable guidance communities need to protect themselves from increasingly dangerous climate events.

Our Extreme Weather RAG System is an AI-powered early warning platform that revolutionizes climate emergency response through intelligent weather analysis, combining IBM watsonx.ai's Granite models with 90+ TB of historical weather data to provide life-saving predictions and actionable guidance for extreme weather preparedness. The system targets emergency management agencies, first responders, community safety coordinators, local governments, weather-dependent industries, and the general public seeking weather safety information. Users interact through a natural language chat interface where they can ask questions like "Hurricane risk for Miami this week?" or use commands like "/analyze [location]" for comprehensive risk assessments, accessing real-time analysis for any global coordinate and receiving four-section intelligence reports covering current conditions, 7-day forecasts, extreme weather predictions, and risk assessments.

Our solution uniquely combines global coverage for any location worldwide through smart geocoding, 90+ TB of historical context from weather patterns spanning 1940-present via Open-Meteo Archive API, AI-enhanced predictions using IBM watsonx.ai Granite models to generate contextual insights, RAG architecture ensuring predictions are grounded in real historical data, and real-time intelligence through WebSocket-powered instant communication with progress updates. The system uses AI in revolutionary ways through historical pattern recognition that analyses decades of weather data to identify emerging threat patterns, contextual risk assessment where RAG combines current conditions with historical extremes for intelligent predictions, natural language weather intelligence that transforms complex meteorological data

into actionable plain-language alerts, and predictive event modelling that forecasts extreme weather events 7+ days in advance with confidence scoring. Unlike traditional weather apps that show basic forecasts, our AI generates intelligent risk narratives explaining why conditions are dangerous and what communities should do, with the RAG architecture ensuring predictions aren't just statistical but contextually aware of local climate patterns and historical precedents. This AI-driven approach saves lives by providing hurricane/typhoon tracking with advanced cyclonic storm prediction, tornado risk assessment through atmospheric instability analysis, heat wave/cold wave detection with health impact warnings, flash flood modelling with precipitation-based risk scoring, and severe storm tracking with community-specific guidance.

Deliverable 2: RAG and IBM watsonx.ai Usage Statement

Our project implements a sophisticated RAG architecture that fundamentally transforms weather prediction by grounding AI responses in comprehensive historical weather data retrieval from multiple sources including the Open-Meteo Archive API containing 90+ TB of historical weather data spanning 1940-present, real-time forecast data providing 16-day predictions with hourly resolution, a global location database enabling worldwide geocoding for any coordinate, and an extreme weather event database containing historical pattern libraries for contextual analysis. When users query weather conditions, our RAG retrieval process pulls 30+ days of recent weather data for the location, obtains 7-day forecasts with hourly granularity, identifies historical weather patterns and anomalies, and compares current conditions against historical extremes to contextualize risk factors. The retrieved weather data enhances AI generation by providing factual grounding for predictions instead of generic responses, enabling location-specific risk assessments based on actual climate history, supporting confidence scoring through historical event frequency analysis, and generating seasonally aware predictions based on long-term patterns.

We utilize IBM watsonx.ai's Granite 13B Instruct v2 model as our core language processing engine, specifically chosen for its superior instruction-following capabilities for weather analysis tasks, robust factual reasoning for meteorological data interpretation, and efficient token usage optimizing our $100 hackathon credit allocation. Our implementation uses the official IBM watsonx.ai SDK with optimized parameters including greedy decoding for factual consistency, 500 max new tokens for comprehensive responses, 0.3 temperature for balanced creativity and accuracy, 0.8 top_p for controlled generation, and 1.1 repetition penalty to avoid redundancy. The AI-enhanced weather analysis pipeline begins with data contextualization where RAG retrieves historical and forecast data, followed by intelligent prompt construction creating weather-specific prompts with retrieved data context, then Granite model processing where IBM watsonx.ai analyses patterns and generates insights,

culminating in structured response generation where AI produces four-section intelligence reports.

IBM watsonx.ai provides specific value through pattern recognition where Granite models identify subtle weather patterns humans might miss, risk communication that transforms complex meteorological data into clear actionable language, contextual reasoning that understands relationships between weather variables and extreme event risks, and predictive insights that generate forward-looking analysis beyond simple data reporting. Our system's power comes from the synergy between RAG data retrieval and watsonx.ai intelligence, where RAG ensures AI responses are factually grounded in real weather data while watsonx.ai transforms raw meteorological information into intelligent risk narratives, with the combined architecture preventing AI hallucination while enabling creative risk communication and historical context retrieval allowing AI to make sophisticated pattern-based predictions. We've enhanced the standard RAG pattern with multi-temporal data fusion combining historical, current, and forecast data streams, geospatial context awareness providing location-specific risk profiling through retrieved climate data, dynamic confidence scoring with AI-generated confidence levels based on historical pattern strength, and progressive disclosure through a four-section report structure optimized for emergency decision-making, creating an intelligent weather analysis system that provides contextually-aware, historically-grounded, and actionably-presented extreme weather predictions that would be impossible with either traditional forecasting or standalone AI generation.